Posterior lumbar interbody fusion with pedicular fixation for surgical treatment of failed back surgery syndrome

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Background
Spine surgery can basically yield only two things: decompression of a nerve root and/or stabilization of painful joints. Failure to achieve both of them leads to continuation of back and/or leg pain because of persistence or recurrence of disc herniation and/or stenosis, infection, and fusion failure. Posterior lumbar interbody fusion (PLIF) has been considered the optimal solution for the above-mentioned problems.

Aim of the work
The aim of the work was to show the effectiveness and safety of PLIF surgery with pedicular fixation in the surgical treatment of failed back surgery syndrome (FBSS).

Study design
Prospective study.

Patients and methods
This study included 24 patients with FBSS treated with PLIF with pedicular fixation and an autogenous tricortical iliac bone graft. There were 14 men and 10 women, aged 30–62 years (average 46 years). Among the 24 patients, 10 had recurrent herniated disc with preoperative or intraoperative noticed spinal instability, eight had failed posterolateral fusion, and six had postoperative spondylodiscitis.

Results
The average Visual Analogue Scale of back pain improved significantly from 7.4 (range 6–9) preoperatively to 2.5 (range 1–5) at the last follow-up. The average Visual Analogue Scale of leg pain improved significantly from 6.1 (range 2–9) preoperatively to 2.8 (range 2–5) at the last follow-up. Finally, the average Oswestry Disability Index improved significantly from 78% (range 60–90%) preoperatively to 36.6% (range 32–48%) at the last follow-up. According to Brantigan evaluation, fusion was considered certain in 23 patients (95.8%) at the last follow-up.

Conclusion
The outcomes of PLIF with pedicular fixation in the surgical management of FBSS were encouraging in terms of significant improvement in back pain and leg pain, with good fusion rate and good quality of life.

Keywords:
failed back surgery syndrome, posterior lumbar interbody fusion, surgical treatment

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Introduction

Failed back surgery syndrome (FBSS) is a very generalized term that is often used to describe the condition of patients who have not had a successful outcome after spine surgery and have experienced continued pain after surgery. Spine surgery can basically yield only two things: decompression of a nerve root and/or stabilization of painful joints. Failure to achieve both of them leads to continuation of back and/or leg pain because of persistence or recurrence of disc herniation and/or stenosis, infection, and fusion failure including failure to fuse, implant failure, and/or transfer of degeneration to another level [1]. From a theoretical point of view, posterior lumbar interbody fusion (PLIF) has been considered the optimal solution for the above-mentioned problems. The theoretical advantages in favor of PLIF include anterior column support, canal and foraminal decompression, restoration of lordosis, and reduction of slip through ligamentotaxis [2]. PLIF is biomechanically stronger, and provides axial support with less graft subsidence or collapse compared with posterolateral fusion (PLF), and produces better biological fusion in lordotic alignment [3,4].

The aim of this prospective study was to show the effectiveness and safety of PLIF surgery with pedicular fixation in the surgical treatment of FBSS.

Patients and methods

This prospective study included 24 patients with FBSS treated with PLIF with pedicular fixation and an autogenous tricortical iliac bone graft in the Orthopaedic Department of Assiut University Hospital from January 2006 to October 2009. Eleven

patients with FBSS were excluded from this study and were not operated on because they had some form of psychological and emotional disturbances, mostly impotence in men and depression in women. These 11 patients were examined and diagnosed by psychologists. There were 14 men and 10 women, aged 30–62 years (average 46 years) (Table 1). The causes of FBSS in this study are shown in Table 2. The study protocol was approved by the ethics committee of our institution and all patients signed an informed consent.

Among the 24 patients, 10 (41.7%) had recurrent herniated disc with preoperative or spinal instability observed intraoperatively (six patients underwent one surgery and four patients underwent two surgeries) (Fig. 1a–d), eight patients (33.3%) had failed PLF (three had broken screws, three had broken rods, and two had screw loosening) (Figs 2a, 2b, 3a, and 3b), and six patients (25%) developed postoperative spondylodiscitis (one of them showed L3–L4 discitis associated with lytic spondylolysthesis L3 over L4 and L4 over L5) (Fig. 4a–c). The diagnosis of postoperative discitis was confirmed clinically, radiologically, and laboratory. The lumbar levels affected and fused are shown in Table 3.

All patients underwent preoperative anteroposterior, lateral, and dynamic radiographic views. MRI was performed for 18 patients (75%), who had significant

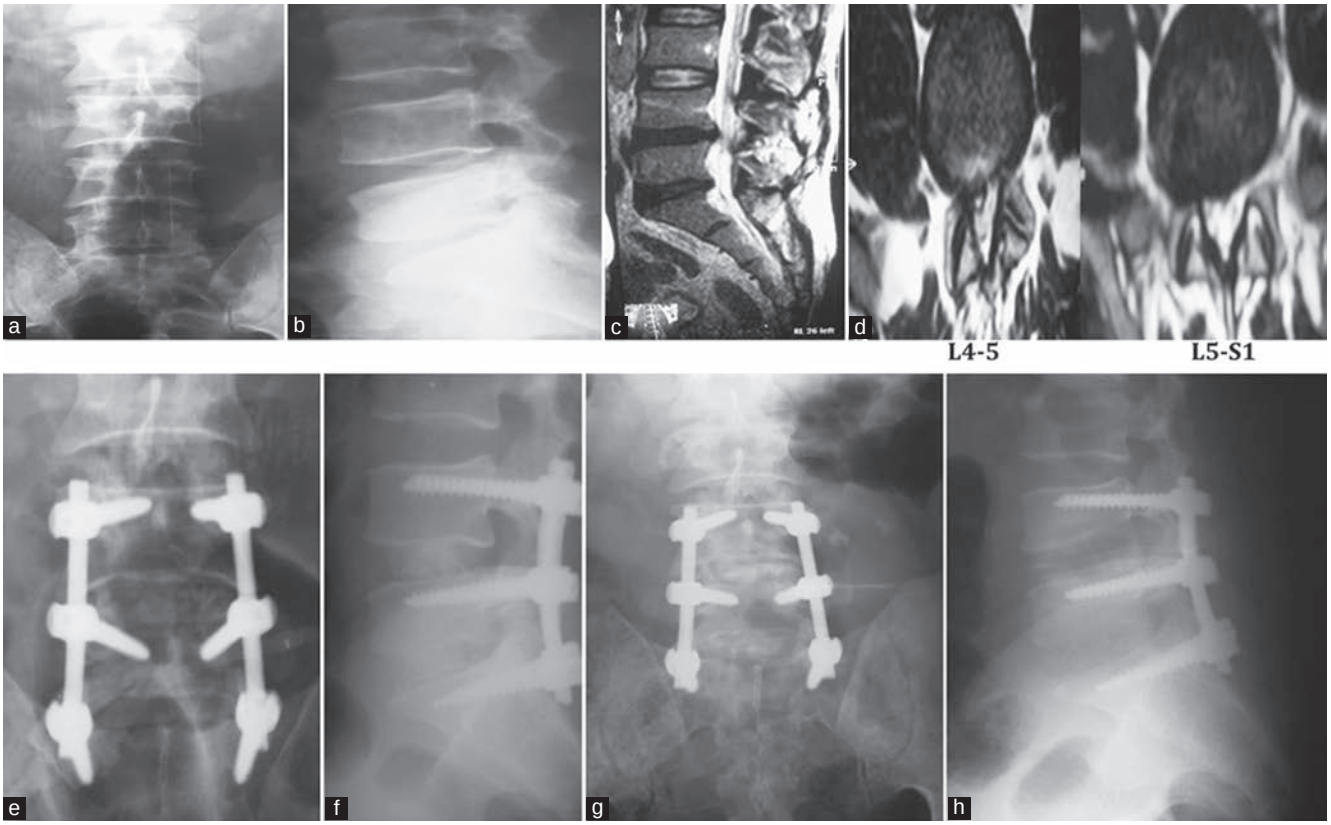
Table 1 Demographic data of the patients

Total number	24
Sex	
Male	14
Female	10
Age	46 years (range 30–62)

Table 2 Causes of failed back surgery syndrome

Causes	*N*	%
Recurrent disc herniation		41.7
Once	6	
Twice	4	
Failed posterolateral fusion		33.3
Broken rods	3	
Broken screws	3	
Loosening of screws	2	
Postoperative discitis	6	25
Total	24	100

Figure 1



A male patient, 49 years old, presented with recurrent disc herniation L4–L5 and L5–S1 with right sciatica, VAS of back and leg pain 6 and 7, respectively, ODI 70%. Intraoperative spinal instability because of facetectomy was observed. (a, b) Preoperative plain radiographs anteroposterior (a) and lateral (b). (c, d) Preoperative sagittal (c) and axial (d) MRI showing right recurrent disc of L4–5 and L5–S1. (e, f) Postoperative anteroposterior (e) and lateral (f) plain radiographs PLIF of L4–L5–S1. (g, h) Last follow-up (1.5 years) anteroposterior (g) and lateral (h) plain radiographs, certain fusion, VAS of back and leg pain 3 and 2, respectively, ODI 38%. ODI, Oswestry Disability Index; PLIF, posterior lumbar interbody fusion; VAS, Visual Analogue Scale.

Figure 2

A male patient, 55 years old, presented with failed posterolateral fusion with decompression of L3–L4–L5, VAS of back and bilateral legs pain 8, and ODI 72%. (a, b) Preoperative anteroposterior (a) and lateral (b) plain radiographs showing screws and nut loosening and instability. (c, d) Postoperative anteroposterior (c) and lateral (d) plain radiographs PLIF of L3–L4–L5. (e, f) Last follow-up (2 years) anteroposterior (e) and lateral (f) plain radiographs, certain fusion, back and leg pain VAS 2 and 3, respectively, ODI 32%. ODI, Oswestry Disability Index; PLIF, posterior lumbar interbody fusion; VAS, Visual Analogue Scale.

Table 3 Levels affected and fused

Level affected	Number	Level fused	Number
L3–L4	6	L3–4	5
L4–L5	10	L4–5	9
L5–S1	7	L5–S1	5
L3–L4–L5	1	L3–L4–L5	2
L4–L5–S1	–	L4–L5–S1	3
Total	24	Total	24

leg pain. Postoperative and follow-up radiographic evaluation was performed at 2, 4, 6, 12, 18, and 24 months postoperatively for most of the patients. Fusion was assessed according to Brantigan [5]. Clinical evaluation for back pain and radicular leg pain of the patients was performed according to the Visual Analogue Scale (VAS) [6]. The Oswestry Disability Index (ODI) was used to assess the functional disability of all patients preoperatively and at the last follow-up [7].

Surgical technique

The patients were placed in a prone position on the operating table.

Metal removal was performed first in patients with failure of PLF. Pedicle screws were placed in the designed levels. Decompressive laminectomy and foraminotomy were then performed unilaterally or bilaterally according to the site of root compression. The facet joints, which lie directly over the nerve root, can be trimmed to allow more room for the nerve roots. Temporary fixation and distraction with a unilateral rod was necessary to open the disc, facilitating its resection. After disc resection, a tricortical iliac bone graft was harvested and impacted in the disc defect. Finally, the contoured second rod was placed and then the first one was replaced by a properly contoured one. Then, the rods were tightened under compressing force.

Results

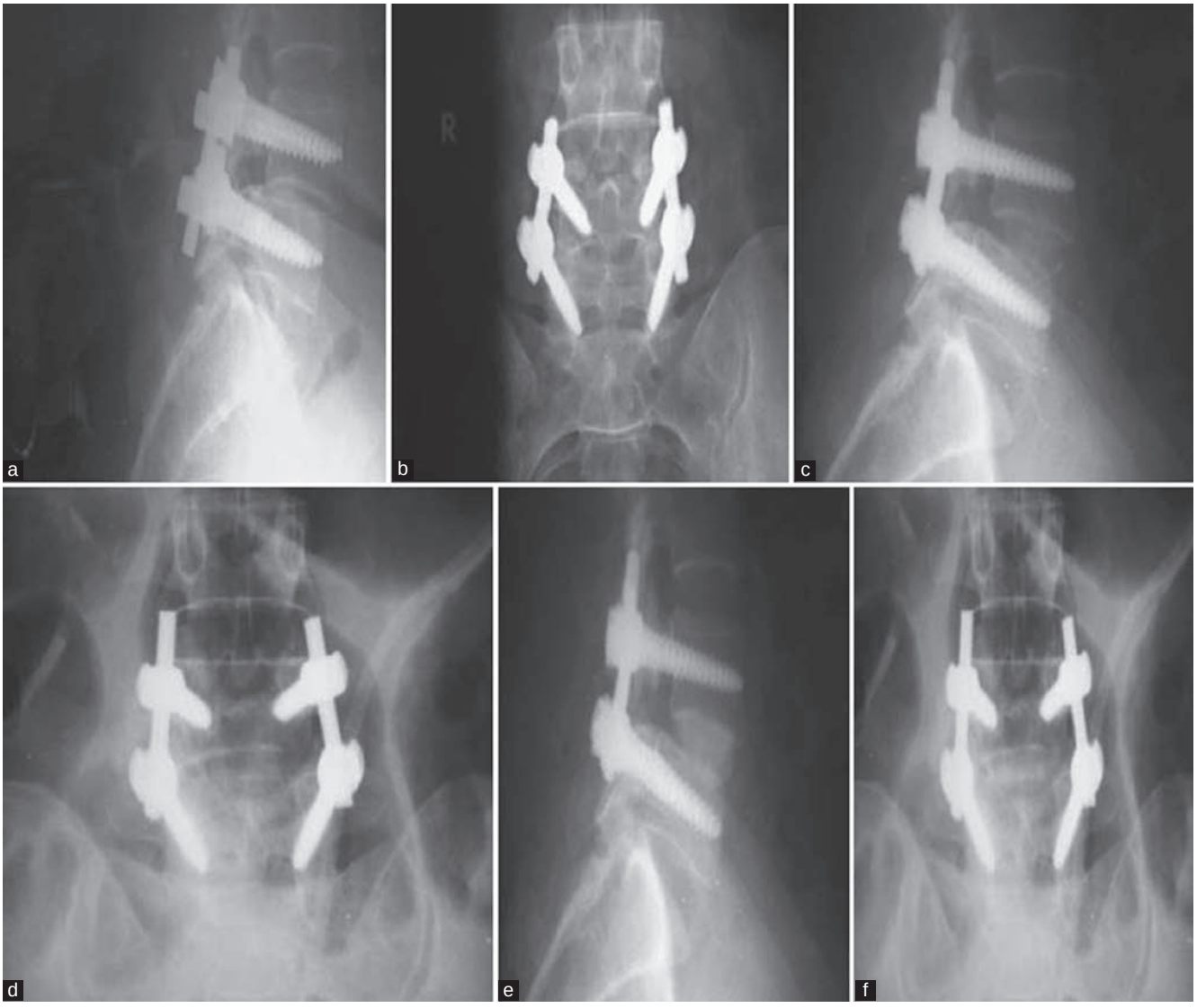
All patients were followed up for at least 15 months, average 19.1 months (range 15–24). The average operative time was 190.4 min (range 150–240). The average blood loss was 692 ml (range 400–1000), whereas the average blood transfusion was 800 ml (range 500–1000). Hospital stay of the patients ranged from 5 to 8 days, with an average of 5.6 days (Table 4).

According to the Brantigan evaluation [5], fusion was considered certain in 23 patients (95.8%) at the last follow-up (Figs 1g, 1h, 2e, 2f, 3e, 3f, 4f, and 4g). Twenty-one patients (87.4%) showed certain fusion at an average follow-up of 8.5 months (range 6–12), whereas two patients (8.4%) presented with uncertain fusion (the trabecular continuity was not obvious) at the 12-month follow-up but it became certain at 18 months. One patient (4.2%) presented with nonunion at the last follow-up (24 months) in the form of graft resorption, loss of lordosis, and persistence of back pain.

Table 4 Intraoperative and postoperative data

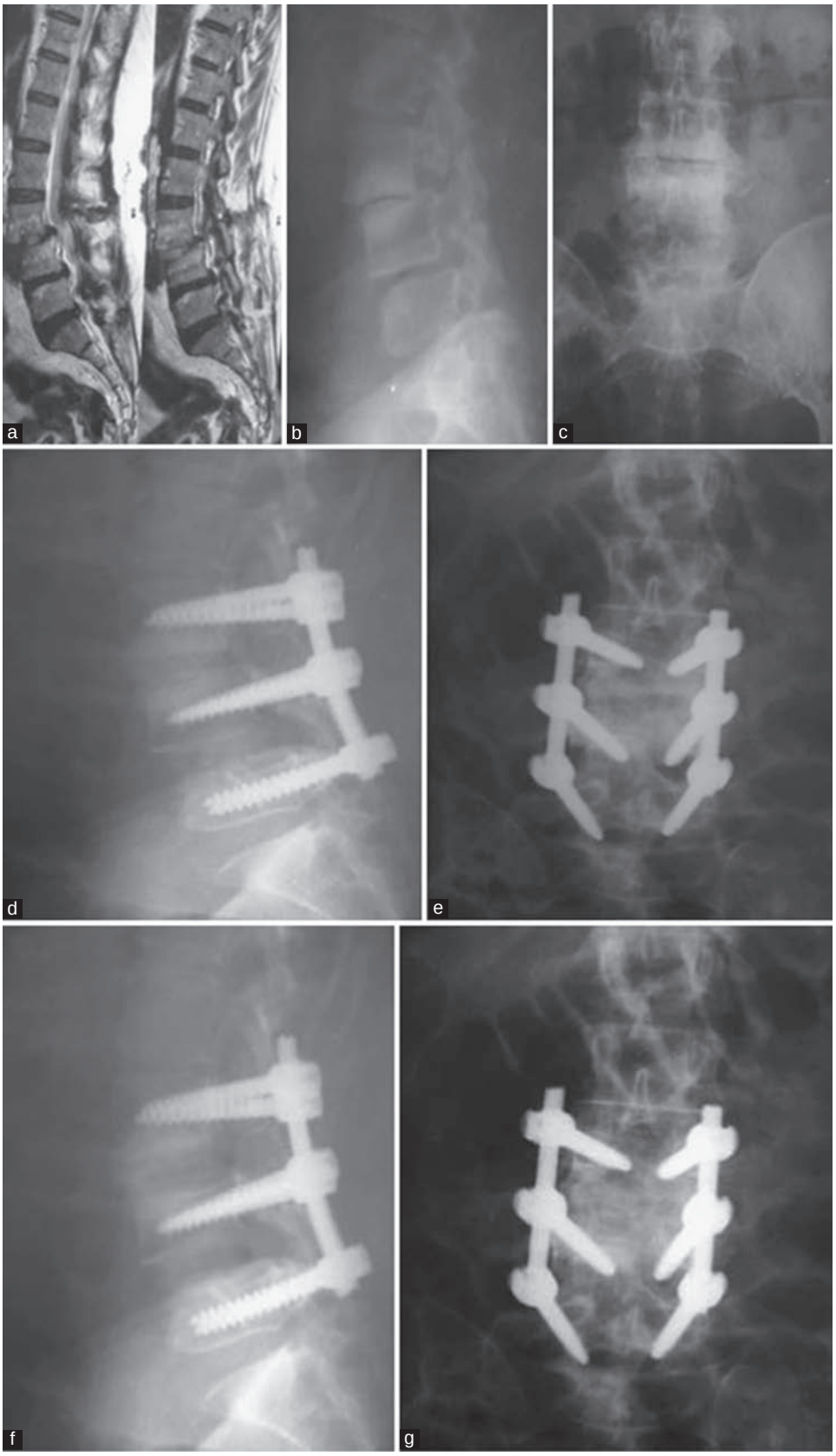
Blood loss	692 ml (range 400–1000)
Blood transfusion	800 ml (range 500–1000)
Duration of surgery	190.4 min (range 150–240)
Hospital stay	5.6 days (range 5–8)
Complications	
Postoperative	Left quadriceps paralysis (grade 2) Right partial drop foot
Last follow-up	L4–L5 nonunion.

Figure 3



A female patient, 42 years old, presented with failed posterolateral fusion of L4–L5 with a broken rod, VAS of back and leg pain 8 and 3, respectively, ODI 65%. (a, b) Preoperative anteroposterior (a) and lateral (b) plain radiographs showing a broken right rod and absent lateral fusion mass. (c, d) Postoperative anteroposterior (c) and lateral (d) plain radiographs P ast follow-up (1.5 years) anteroposterior (e) and lateral (f) plain radiographs showing certain fusion, VAS of back and leg pain 3, ODI 34%. ODI, Oswestry Disability Index; PLIF, posterior lumbar interbody fusion; VAS, Visual Analogue Scale.

Figure 4



A female patient, 55 years old, presented with postdiscectomy discitis of L3–L4 (increased ESR and CRP) showing lytic spondylolisthesis of L3 over L4 and L4 over L5,VAS of back and leg pain 9 and 6, respectively, ODI 90%. (a, b) Preoperative anteroposterior (a) and lateral (b) plain radiographs.(c) Preoperative sagittal views of MRI showing L3–L4 spondylodiscitis with L3–L4 and L4–L5 instability. Intraoperative L3–L4 sequestrated disc was noticed. (d, e) Postoperative anteroposterior (d) and lateral (e) plain radiographs PLIF of L3–L4–L5. (f, g) Last follow-up (2 years) anteroposterior (f) and lateral (g) showing certain fusion, VAS of back and leg pain 3 and 2, respectively, ODI 32%. ODI, Oswestry Disability Index; PLIF, posterior lumbar interbody fusion; VAS, Visual Analogue Scale.

The clinical outcomes including back and leg pain were evaluated according to the VAS [6]. All patients presented with back pain with different grades of severity, but was greater in the postoperative discitis group (Table 5). The average VAS of back pain improved significantly from 7.4 (range 6–9) preoperatively to 2.5 (range 1–5) at the last follow-up (P = 0.001; Table 6). Significant leg pain was present in 18 patients (75%), mainly in the recurrent disc herniation group (Table 5). The average VAS of leg pain improved significantly from 6.1 (range 2–9) preoperatively to 2.8 (range 2–5) at the last follow-up (P = 0.001; Table 6).

The functional disability of the patients was evaluated according to the ODI [7], which includes pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and traveling. In the current study, the average ODI improved significantly from 78% (range 60–90%) preoperatively to 36.6% (range 32–48%) at the last follow-up (P = 0.001; Table 6).

Complication

Neurological deficits were recorded in two patients (8.4%); one of them, with recurrent disc herniation of L3–L4, developed weakness of the left quadriceps (grade 2) and the other, with L4–5 spondylodiscitis, developed partial drop of the right foot. Both these patients showed complete improvement at the 4-month follow-up.

Nonunion was recorded in one patient (4.2%). This patient was obese, diabetic, and a heavy smoker, and he presented with recurrent disc herniation at L4–L5.

Discussion

FBSS is a chronic pain condition that has a huge impact on the patient and healthcare system.

Despite advances in surgical technology, the rate of FBSS has not decreased. The rate of occurrence of FBSS in the available literature ranges from 5 to 50% [8,9]. The factors contributing toward the development of this entity may occur in the preoperative, intraoperative, and postoperative period. Over 50% of patients with FBSS have been found to have some form of psychological and emotional instability. Thus, preoperative identification of such conditions is very important for avoidance of potential FBSS [10]. In the current study, 11 patients with FBSS were excluded and not operated on because of psychological disturbances that might cause further back surgery failure. Because of the severe pain and disability that is caused by this syndrome, more radical treatment has been utilized [11]. Despite extensive work in recent years, FBSS remains a challenging and expensive disorder. Recent advances in surgical reconstruction, rehabilitation, and pain management techniques offer hope for patients with this painful and disabling condition [12].

PLIF is considered one of the most effective radical surgical options in the management of FBSS. In theory, interbody fusion provides several advantages compared with other fusion techniques [13,14]. It immobilizes the painful degenerated spinal segments, decompresses the nerve roots, and restores disc height and root canal dimensions as well as the load-bearing ability of anterior structures [15]. Interbody fusion techniques were developed in an attempt to preserve the load-bearing capacity of the spine, restore the sagittal alignment, and use the compressive loading on the bone to enhance fusion [2,16,17].

In the current study, 24 patients presented with different causes of FBSS including recurrent lumbar disc herniation with spinal instability observed preoperatively or intraoperatively (41.7%), failed PLF (33.3%), and postoperative spondylodiscitis (25%). All patients presented with severe low back pain, with an average preoperative VAS of 7.4, and it was more severe in the postoperative spondylodiscitis group, in which the average VAS was 8.5. Among the 24 patients, 18 patients (75%) presented with significant leg pain. The average VAS of leg pain was 6.1. It was more severe in the recurrent disc herniation group, in which the average VAS was 6.9. Both back pain and leg pain improved significantly at the last follow-up, with an average VAS of 2.5 and 2.8, respectively (P = 0.001). These results are comparable with those reported by Jang *et al.* [18] as VAS of back pain and

Table 5 Visual Analogue Scale of back and leg pain of different causes of failed back surgery syndrome preoperative and at the last follow-up

Causes	*N*	Back pain (preoperative)	Back pain (last follow-up)	*P* value	Leg pain (preoperative)	Leg pain (last follow-up)	*P* value
Recurrent disc herniation	10	6.7	3	0.004*	6.9	2.7	0.011*
Failed posterolateral fusion	8	7.6	2.5	0.010*	6.1	3.1	0.024*
Postoperative discitis	6	8.5	1.8	0.026*	6.2	2.2	0.041*

Wilcoxon's signed-rank test.
*Statistically significant difference (P<0.05).

Table 6 Visual Analogue Scale and Oswestry Disability Index preoperatively and at the last follow-up of all patients

	Preoperative	Last follow-up	*P* value
VAS			
Back pain	7.4 (range 6–9)	2.5 (range 1–5)	0.001*
Leg pain	6.1 (range 2–9)	2.8 (range 2–5)	0.001*
ODI	78% (range 60–90)	36.6% (range 32–48)	0.001*

ODI, Oswestry Disability Index; VAS, Visual Analogue Scale.
Wilcoxon's signed-rank test.
*Statistically significant difference ($P<0.05$).

leg pain improved significantly from 7.2 and 6.8 to 3 and 3.2, respectively. Similar results were reported by Kat'uch *et al.* [19], who treated 58 patients with FBSS using the PLIF technique as VAS of back and leg pain improved significantly from 7.95 preoperatively to 2.82 at the last follow-up.

The significant improvement in low back pain can be attributed to the wide area of fusion, and reduction of slip if present, in addition to the removal of the diseased or degenerated disc, which is one of the sources of back pain. Per [20] attributed radicular pain improvement to direct and indirect nerve root decompression, which is considered one of the theoretical advantages of PLIF.

Using a tricortical autogenous iliac bone graft in this study, fusion was considered certain in 23 patients (95.8%); 21 of these patients (87.4%) showed certain fusion at an average 8.5 months, whereas two patients (8.4%) presented with uncertain fusion at the 12-month follow-up but it became certain at 18 months. One patient (4.2%) showed nonunion in the form of graft resorption, loss of lumbar lordosis, and persistence of significant back pain at the 24-month follow-up. Comparable results were reported by Dong *et al.* [21], who treated 53 patients with PLIF using a central single cage and a local morselized bone graft. They reported a fusion rate of 98.1%. An iliac crest bone graft facilitates rapid bone union but still carries the risk of excessive blood loss, donor site infection, another skin incision, and increased operative time.

Complications associated with PLIF can be serious. They are often related to excessive retraction of the nerve root or the dural sac.

According to various reports, these serious complications occurred in 4–10% of the patients who are subjected to this technique [22]. In the current study, two patients (8.4%) showed neurological deterioration postoperatively. One showed left quadriceps paralysis (grade 2) and the other developed partial drop of the right foot. Both patients showed complete improvement at the 4-month follow-up. One patient (4.2%) presented with nonunion at the last follow-up. This patient was obese, diabetic, and a heavy smoker, which may be the reasons for this nonunion.

The ODI has been designed to provide the doctor with information about how the pain has affected the patient's ability to manage everyday life activity, which includes pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and traveling [7]. In the Jang *et al.* [18] and Kat'uch *et al.* series [19], ODI improved from 62 and 71.7% preoperatively to 36 and 37.7% at the last follow-up, respectively. Comparable results were obtained in the current study as ODI improved significantly from 78% preoperatively to 36.6% at the last follow-up ($P = 0.001$).

Optimal patient selection and correct choice of the procedure to be performed in patients with spine problems play a huge role in FBSS prevention. Once FBSS has occurred, PLIF is the procedure of choice for its surgical treatment after exclusion of all psychological and emotional factors that may interfere with any success.

Conclusion

The outcomes of PLIF with pedicular fixation in the surgical management of FBSS were encouraging in terms of significant improvement in back pain and leg pain with a good fusion rate, in addition to significant improvement in quality of life. Despite the few transient complications related to this procedure, the procedure was relatively safe.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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